Benthic Macroinvertebrate Bioassessment

Data Summary Memo

2022

June 12, 2023

Morro Bay National Estuary Program
601 Embarcadero, Suite 11
Morro Bay, CA 93442

Table of Contents

Acknowledgements

The Morro Bay National Estuary Program would like to thank the following individuals and organizations for their time, effort, and support, all of which have made this project possible:

- The Harold J. Miossi Charitable Trust for their generous grant, which has funded this monitoring effort since 2013.
- Our dedicated volunteers who have donated their time to help ensure the success of the project.
- The many landowners who have allowed access for this monitoring.

List of Acronyms

Acronym	Definition
BMI	Benthic Macroinvertebrate
CDFW	California Department of Fish and Wildlife
CCRWQCB	Central Coast Regional Water Quality Control Board
CSCI	California Stream Condition Index
EPT	Ephemeroptera, Plecoptera, and Trichoptera
Estuary Program	Morro Bay National Estuary Program
RWB	Reach-wide benthos (biotic sampling method)
MLML	Moss Landing Marine Laboratory
SAFIT	Southwest Association of Freshwater Invertebrate Taxonomists
SoCal B-IBI (IBI)	Southern California Coastal Index of Biotic Integrity
SWAMP	Surface Water Ambient Monitoring Program
WY	Water Year (Oct 1 to September 30; named for the year in which it ends)

Citation

This report should be cited as follows:

Morro Bay National Estuary Program's Benthic Macroinvertebrate Bioassessment Data Summary Memo 2022. Morro Bay National Estuary Program. June 2023.

Introduction

The Morro Bay National Estuary Program (Estuary Program) is a nonprofit organization that brings together citizens, local governments, nonprofits, agencies, and landowners to protect and restore the Morro Bay estuary and the surrounding watershed. The monitoring conducted by staff and volunteers has three main goals: 1) assess long-term ambient trends, 2) track the effectiveness of specific implementation projects, and 3) to establish protection and restoration targets.

The Estuary Program conducts monitoring within the Morro Bay watershed, which is approximately 77 square miles. The watershed is largely dominated by agricultural use, with some urban land use primarily along the coast. The inland watershed drains west into the Morro Bay estuary via two primary creeks, Chorro Creek and Los Osos Creek.

Benthic macroinvertebrates (BMIs) are bottom-dwelling organisms, composed mainly of insects in their larval stage as well as other small aquatic species. These organisms are sensitive to changes in stream chemistry and substrate conditions, and therefore provide a means of assessing waterbody health over time (Barbour, 1999).

This report summarizes the results of benthic macroinvertebrate samples collected during bioassessment surveys from 1994 to 2022[1] from Chorro Creek, Los Osos Creek, and their tributaries. Bioassessment monitoring is conducted per the Surface Water Ambient Monitoring Program (SWAMP) *Standard Operating Procedures (SOP) for the Collection of Field Data for Bioassessments of California Wadeable Streams* (Ode et. al, 2016). This protocol incorporates physical, chemical, and biotic factors that can be used to measure and assess impacts to surface water ecosystems over time. EcoAnalysts, Inc. analyzes the biotic samples, and the Moss Landing Marine Laboratory (MLML) calculates metric scores.

Sites

The Estuary Program conducts bioassessment surveys each spring at various locations throughout the Morro Bay watershed (Figure 1). Typically, ten site locations are selected for monitoring each year. The site selection process is dictated by several factors, including site status ("core" or "rotating"), site access, creek conditions, and adequate staffing. There are six core sites that are monitored every year and a number of rotating sites that are generally monitored every other or every third year. The Estuary Program is also working to establish a reference site, which would represent a benchmark of biological conditions in a minimally disturbed environment.

Sites not listed as either core, rotating, or reference are historic sites that are no longer monitored due to access issues or unfavorable monitoring conditions. Due to the COVID-19 pandemic in 2020 and 2021, additional factors contributed to site selection, including adequate space for social distancing and sites that could be monitored with a small staff-only crew.

During the 2022 effort, Estuary Program staff and volunteers conducted ten surveys. Monitoring locations included five core sites, two rotating sites, and three potential reference sites. Only five of the six core sites could be monitored due to issues with site access at Upper Los Osos Creek (site code CLK).

[1] Prior to 2002, data was collected by the Central Coast Regional Water Quality Control Board (CCRWQCB).

The sites monitored as potential reference sites included two sites on upper Pennington Creek (UMP, UNP), as well as one new site on upper Chorro Creek above the Chorro Reservoir (UCD).

Table 1. *Bioassessment sites codes and locations monitored in 2022. Sites with an asterisk (*) indicate a new monitoring site in 2022.*

Site Code	Location	Type
310TWB	Lower Chorro Creek	Core
310CHD	Upper Chorro Creek below Chorro Reservoir	Rotating
310UCD*	Upper Chorro Creek above Chorro Reservoir	Potential reference
310DAU	Upper Dairy Creek	Core
310UPN	Pennington Creek	Core
310UNP	Upper Northern Pennington Creek	Potential reference
310UMP	Upper Middle Pennington Creek	Potential reference
310LSL	Lower San Luisito Creek	Core
310USL	Upper San Luisito Creek	Rotating
310MNO	San Bernardo Creek	Core

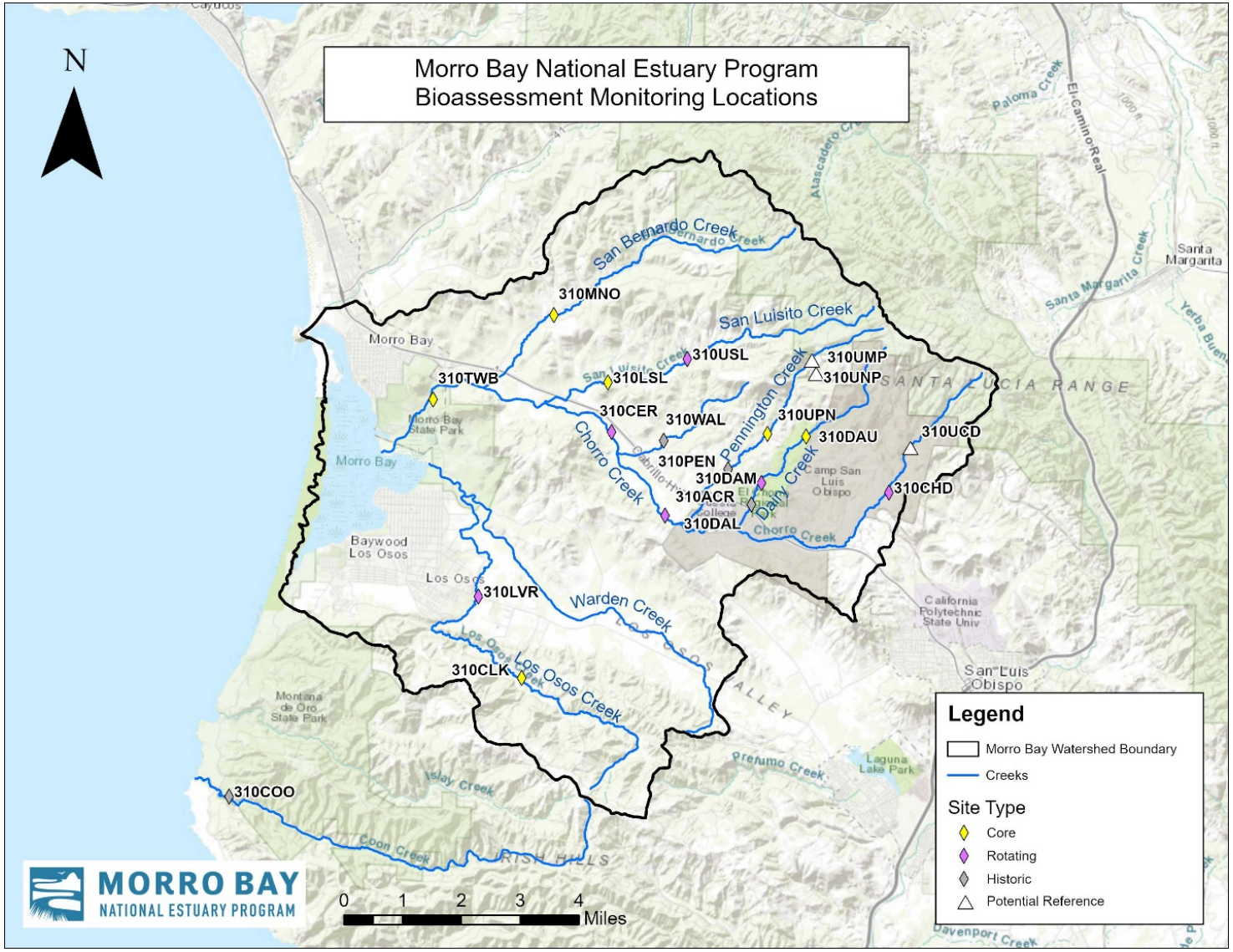

Figure 1. *Core, rotating, and historic bioassessment monitoring locations. Potential reference sites are located in the upper watershed and denoted with a white triangle.*

Methods

The Estuary Program conducts annual spring bioassessment surveys per the SWAMP Standard Operating Procedures protocol (Ode et. al, 2016). Due to limited sampling resources, the Estuary Program does not conduct the algae collection module. All surveys are conducted under a scientific collection permit (SCP) from the California Department of Fish and Wildlife (CDFW). The Estuary Program conducts all required notifications and reporting to maintain the SCP.

At each established site, the Estuary Program conducts a survey along a 150-meter reach that is returned to each sampling year. Measurements and observations are taken at 11 equidistant main transects and ten equidistant inter-transects. These include wetted width, water depth, substrate size, canopy cover, slope, bank stability, and algal observations. Macroinvertebrate samples are collected from each of the 11 main transect locations using the reach-wide benthos (RWB) method, rotating between the margins and center of the creek. The samples are then composited into a single sample and preserved before shipping to a certified laboratory for analysis.

In 2022, the Estuary Program sent macroinvertebrate samples to a certified taxonomy laboratory, EcoAnalysts Inc., for analysis per Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) Level 2 protocols. The samples were sorted, counted, and identified by certified taxonomists until 600 organisms were identified. EcoAnalysts Inc. provided a spreadsheet containing the taxa classifications and several calculated metrics and indices. The Estuary Program contracted with Moss Landing Marine Labs (MLML) to calculate index scores using the California Stream Condition Index (CSCI) analysis method. The data obtained from EcoAnalysts and MLML provide the foundation for the analysis presented in this report.

Results

The following tables, graphs, and maps summarize the results of the 2022 macroinvertebrate sampling effort and provide context for the results by comparing them to historical data. The metrics and indices presented throughout this report typically decrease in response to disturbance, so higher values generally indicate optimal conditions and lower values indicate less ideal conditions. The code “ND” within any table indicates “No Data” and that no monitoring occurred that year. An absence of a bar on bar graphs indicates no monitoring occurred that year.

Taxa Metrics

The calculated metrics included in this report are as follows:

- **Taxa richness** is a measure of the number of different species of organisms in the sample.
- **EPT richness** is a measure of the total number of taxa within the sensitive orders of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), which are collectively known as EPT.
- **EPT percent** is the percentage of EPT individuals within the total number of individuals in a given sample.

- **Percent sensitive EPT** is the percentage of EPT individuals with associated tolerance values of 0 to 3.

Table 2. Benthic taxa metric scores from 2020 to 2022.

Site	Year	Taxa Richness	EPT Richness	% EPT	% Sensitive EPT
MNO (San Bernado Creek)	2020	61.00	14.00	25.90	8.75
	2021	47.00	11.00	12.20	3.08
	2022	66.00	15.00	21.44	7.96
LSL (Lower San Luisito Creek)	2020	55.00	15.00	7.73	5.25
	2021	48.00	16.00	42.43	8.62
	2022	58.00	17.00	40.78	13.77
USL (Upper San Luisito Creek)	2020	32.00	14.00	13.58	51.37
	2021	ND	ND	ND	ND
	2022	64.00	17.00	49.62	33.22
DAU (Upper Dairy Creek)	2020	ND	ND	ND	ND
	2021	27.00	6.00	32.23	25.00
	2022	66.00	16.00	21.17	22.25
UPN (Upper Pennington Creek)	2020	67.00	20.00	24.85	26.41
	2021	61.00	15.00	19.69	15.37
	2022	60.00	17.00	20.70	11.68
UNP (Upper North Pennington)	2020	ND	ND	ND	ND
	2021	64.00	16.00	17.05	15.15
	2022	66.00	17.00	19.44	19.56
UMP (Upper Middle Pennington)	2020	ND	ND	ND	ND
	2021	51.00	16.00	17.53	16.67
	2022	50.00	15.00	19.08	19.82
TWB (Lower Chorro Creek)	2020	47.00	9.00	26.72	7.01
	2021	40.00	6.00	7.37	0.95
	2022	44.00	8.00	13.38	2.40
CHD (Below Chorro Reservoir)	2020	ND	ND	ND	ND
	2021	ND	ND	ND	ND
	2022	62.00	14.00	21.87	13.58
UCD (Above Chorro Reservoir)	2020	ND	ND	ND	ND
	2021	ND	ND	ND	ND
	2022	81.00	22.00	21.86	11.55

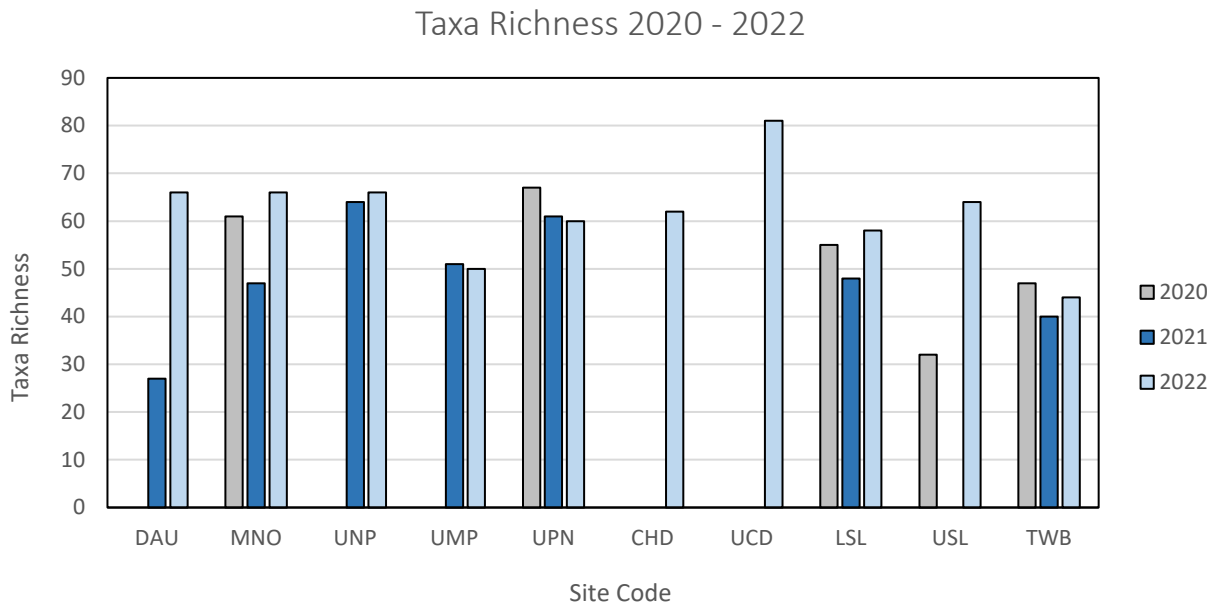

Figure 1. *Taxa richness data for 2020 to 2022 macroinvertebrate sampling.*

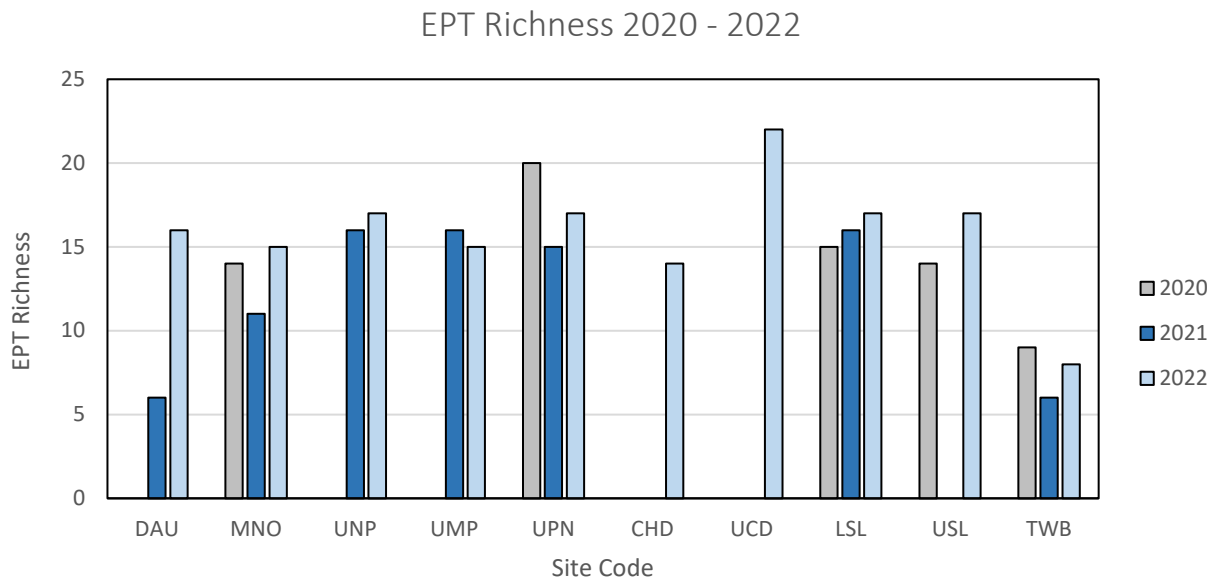

Figure 2. *EPT richness data for 2020 to 2022 macroinvertebrate sampling.*

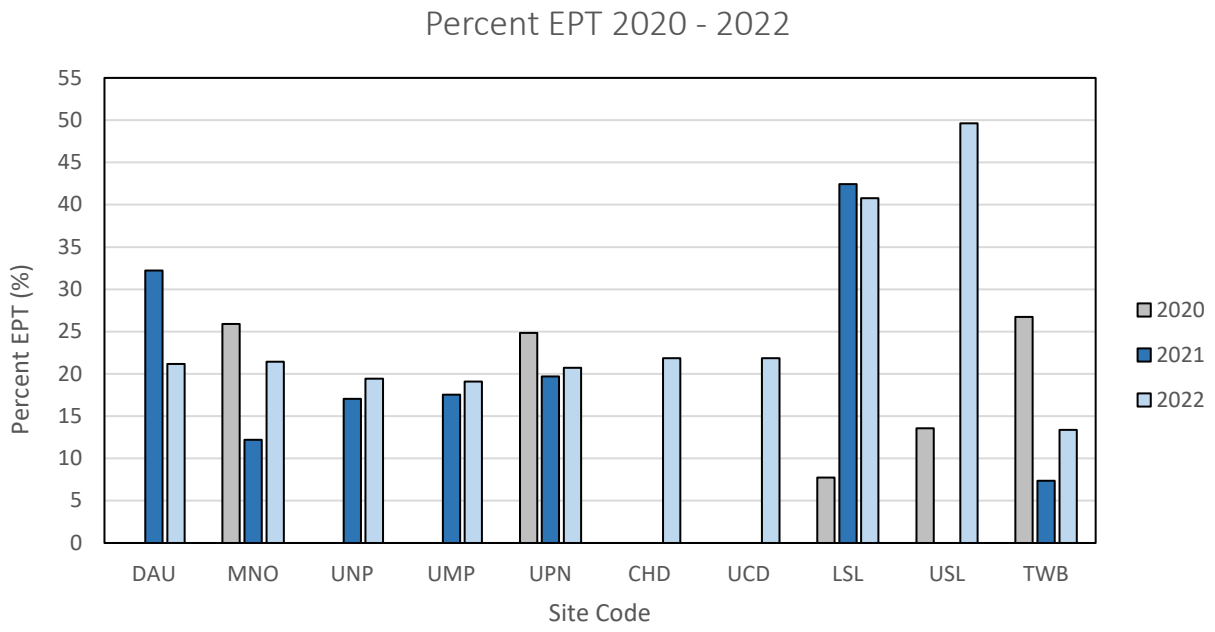

Figure 3. *Percent EPT data for 2020 to 2022 macroinvertebrate sampling.*

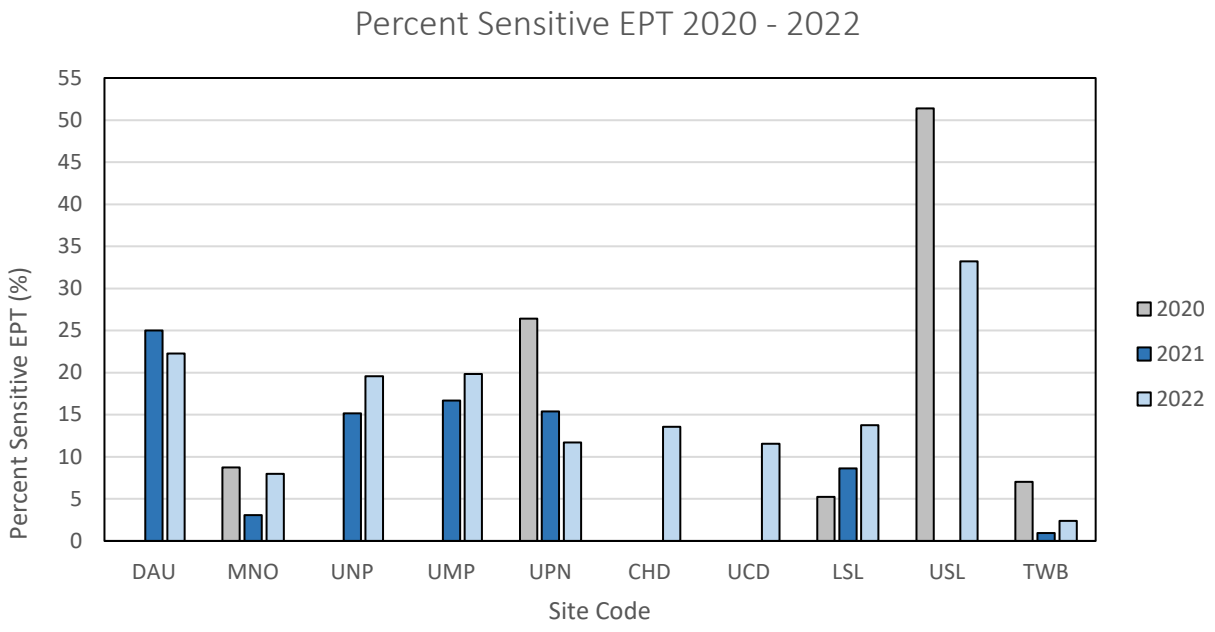

Figure 4. *Percent sensitive EPT data for 2020 to 2022 macroinvertebrate sampling.*

Biotic Indices

The Estuary Program uses a statewide biological scoring tool to assess overall stream health called the California Stream Condition Index (CSCI). The CSCI uses both biotic and environmental data to measure how well a site's observed condition matches its expected condition using a numeric scoring system to interpret stream degradation, as seen in Table 3 (Rehn et al., 2015).

Historically, the Estuary Program used the Southern California Coastal Index of Biotic Integrity (SoCal B-IBI, or IBI) as a primary index for classifying stream health. But as the metric was designed for the coastal region from Monterey to San Diego[2], the method doesn't allow for direct comparison with data from outside of this geographic area. The Estuary Program recently adopted the use of the CSCI, which is not tied to a specific region in California. This was driven in part by a shift by the State Water Resources Control Board to utilize CSCI for its own analysis of waterbody impairment.

Table 3. *CSCI score ranges and associated categories, adapted from Rehn et al, 2015.*

CSCI Score	CSCI Score Category
> 1.00	Better ecological and biological stream conditions than expected
≥ 0.92 up to 1.00	Likely intact stream conditions
≥ 0.79 up to 0.92	Possibly altered stream conditions
0.63 to 0.79	Likely altered stream conditions
≤ 0.62	Very likely altered stream conditions

The following table shows a comparison of recent CSCI scores using the classifications outlined in Table 3. A table of all CSCI scores are available in Appendix A.

[2] The SoCal IBI score is only applicable in a range from Monterey to San Diego. This region tracks closely with the jurisdictions of Regional Water Quality Control Boards 3, 4, 8, and 9.

Table 4. *CSCI scores from 2020 to 2022. Sites with "ND" indicates that no data was collected.*

Site	Year	CSCI	CSCI Status
MNO (San Bernardo Creek)	2020	0.97	Likely Intact
	2021	0.82	Possibly Altered
	2022	0.94	Likely Intact
LSL (Lower San Luisito Creek)	2020	0.88	Possibly Altered
	2021	0.98	Likely Intact
	2022	1.02	Likely Intact
DAU (Upper Dairy Creek)	2020	ND	ND
	2021	0.8	Possibly Altered
	2022	0.92	Likely Intact
UPN (Upper Pennington Creek)	2020	0.98	Likely Intact
	2021	0.97	Likely Intact
	2022	1.13	Better than expected
UNP (Upper North Pennington)	2020	ND	ND
	2021	0.79	Likely Altered
	2022	0.84	Possibly Altered
UMP (Upper Middle Pennington)	2020	ND	ND
	2021	0.96	Likely Intact
	2022	0.89	Possibly Altered
TWB (Lower Chorro Creek)	2020	0.97	Likely Intact
	2021	0.79	Likely Altered
	2022	0.85	Possibly Altered
CHD (Below Chorro Reservoir)	2020	ND	ND
	2021	ND	ND
	2022	0.88	Possibly Altered
UCD (Above Chorro Reservoir)	2020	ND	ND
	2021	ND	ND
	2022	1.04	Better than expected

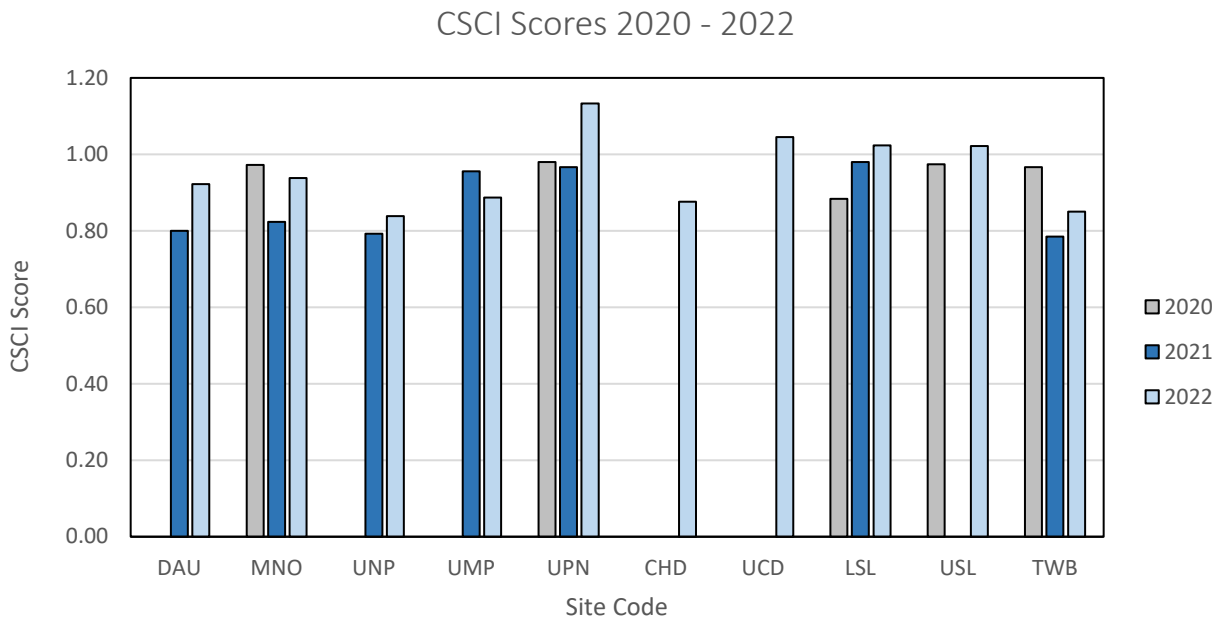

Figure 5. *CSCI scores for 2020 to 2022 bioassessment monitoring.*

The following table and figures illustrate the spatial distribution of CSCI scores in the watershed. Table 5 shows all historic CSCI scores from 1994 to 2022, separated by creek mainstem. Scores are color-coded based on their CSCI score designation. Figure 8 shows the distribution of CSCI scores along mainstem creek segments during 2022. Figure 9 shows the distribution of historic CSCI scores along mainstem creek segments using averaged data from 1994 to 2022. CSCI score criteria is available in Table 3.

Table 5. *CSCI scores of Morro Bay watershed creek sites from 1994 to 2022.*

Year	Chorro Creek					Dairy Creek			Pennington Creek				Walters Creek	San Luisito Creek		San Bernardo Creek	Los Osos Creek		Coon Creek
Site Code	UCD	CHD	ACR	CER	TWB	DAU	DAM	DAL	PEN	UMP	UNP	UPN	WAL	LSL	USL	MNO	CLK	LVR	COO
1994	*	0.70	*	*	*	0.94	0.62	*	0.94	*	*	*	*	*	*	*	*	*	*
1995	*	0.57	*	*	*	0.61	0.71	*	0.85	*	*	*	*	*	*	*	*	*	*
1996	*	0.76	*	*	*		1.09	*	1.17	*	*	*	0.48	*	*	*	1.02	1.05	*
1997	*	0.84	*	*	0.73	1.12	1.09	1.13	1.13	*	*	*	0.49	*	*	*	1.02	*	1.13
1998	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1999	*	*	*	*	*	0.40	0.87	0.88	1.04	*	*	*	*	*	*	*	1.06	*	*
2000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2001	*	0.76	*	*	*	1.07	*	1.18	0.98	*	*	*	0.75	*	*	*	*	*	*
2002	*	*	*	*	0.73	*	*	*	*	*	*	*	*	*	*	*	0.93	*	0.97
2003	*	*	*	0.82	0.74	*	*	0.87	*	*	*	*	*	*	*	*	0.96	*	0.98
2004	*	0.85	*	0.67	*	*	*	0.77	0.85	*	*	*	*	*	*	*	0.94	*	*
2005	*		*	0.67	*	*	*	0.75	*	*	*	*	*	*	*	*	0.74	*	*
2006	*	0.71	*	*	0.90	*	*	0.83	0.82	*	*	0.97	*	*	*	*	0.88	*	1.05
2007	*	0.82	*	0.75	0.82	*	*	*	*	*	*	1.09	*	*	*	*	*	*	1.26
2008	*	0.81	*	0.77	1.03	1.02	0.82	0.85	*	*	*	1.17	0.44	0.98	*	1.03	0.76	*	1.13
2009	*	*	*	0.70	*	1.03	0.96	*	*	*	*	*	*	0.98	*	*	*	*	*
2010	*	*	*	*	*	1.08	0.70	0.74	*	*	*	*	0.56	1.03	1.15	1.01	0.95	0.57	*
2011	*	0.92	*	0.84	*	1.03	1.14	*	*	*	*	1.13	*	1.00	1.09	0.99	1.06	0.91	*
2012	*	*	*	0.87	0.79	*	*	*	*	*	*	1.04	*	1.06	*	1.01	0.85	*	*
2013	*	*	*	0.59	0.91	*	*	*	*	*	*	1.13	*	0.68	0.92	1.02	*	*	*
2014	*	*	*	0.66	0.78	*	*	*	*	*	*	1.04	*	0.86	0.89	0.61	*	*	*
2015	*	0.77	*	0.79	0.61	*	*	*	*	*	*	0.88	*	0.97	1.03	0.72	*	*	*
2016	*	0.82	*	0.81	0.71	*	*	*	0.83	*	*	1.04	*	1.00	1.09	0.86	*	*	*
2017	*	0.78	*	0.82	0.98	0.98	0.81	*	*	*	*	1.10	*	1.04	*	0.98	0.76	0.64	1.07
2018	*	0.92	*	0.79	0.96	1.20	*	*	*	*	*	1.06	*	1.10	1.17	1.06	0.75	*	0.97
2019	*	*	0.86	0.76	0.91	0.92	0.82	*	*	*	*	0.98	*	1.05	*	1.11	0.90	0.65	*
2020	*	*	0.83	*	0.97	*	*	*	*	*	*	0.98	*	0.88	0.97	0.97	0.97	*	*
2021	*	*	0.68	0.58	0.79	0.80	0.82	*	*	0.96	0.79	0.97	*	0.98	*	0.82	*	*	*
2022	1.04	0.88	*	*	0.85	0.92	*	*	*	0.89	0.84	1.13	*	1.02	1.02	0.94	*	*	*
Average CSCI	*	**0.79**	**0.79**	**0.74**	**0.84**	**0.94**	**0.87**	**0.89**	**0.96**	**0.92**	**0.82**	**1.05**	**0.54**	**0.98**	**1.04**	**0.94**	**0.91**	**0.77**	**1.07**

CSCI Score	CSCI Score Category
> 1.00	Better ecological and biological stream conditions than expected
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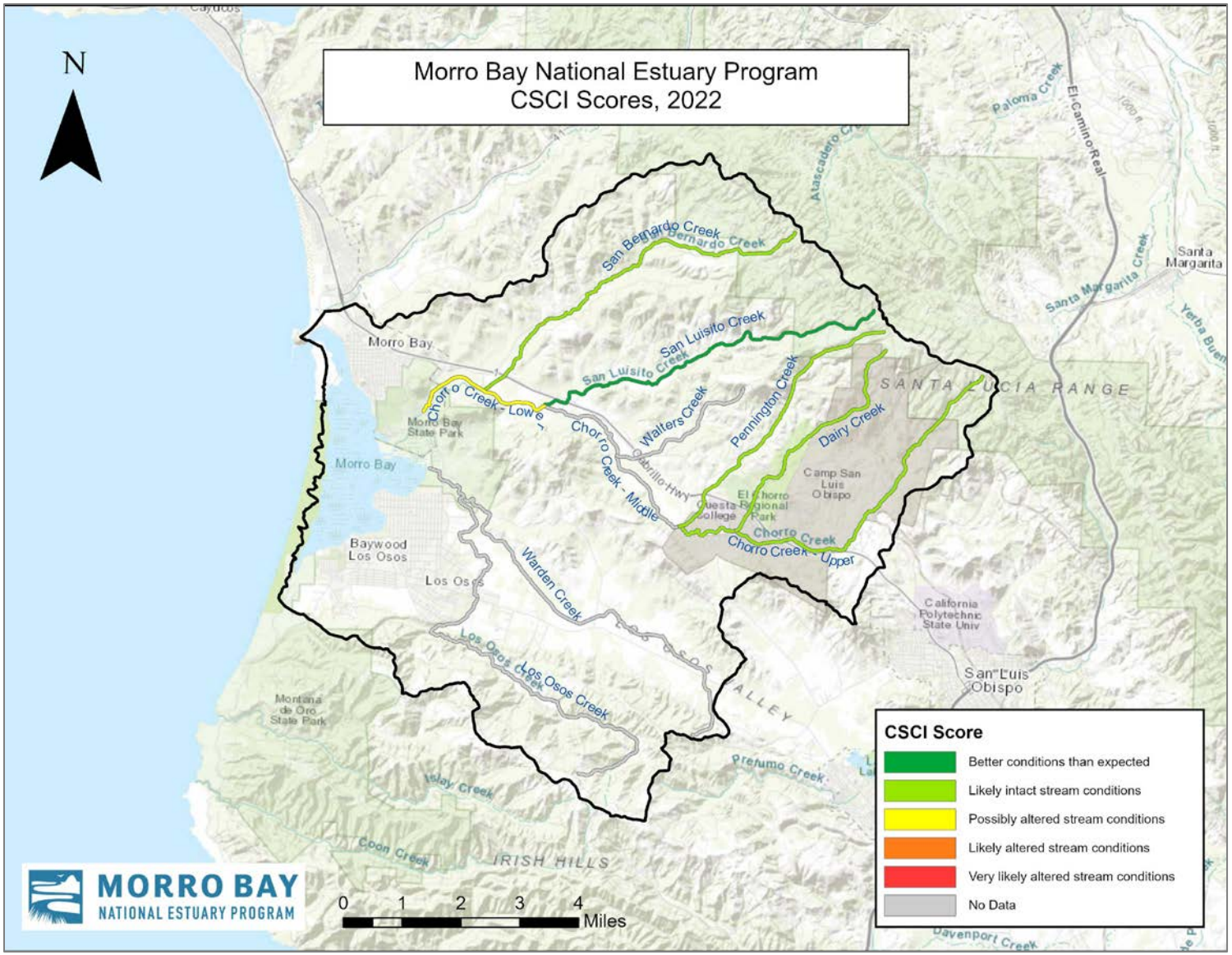

Figure 6. *Mainstem stream segments and their ecological health designations based on 2022 CSCI scores averaged by creek segment.*

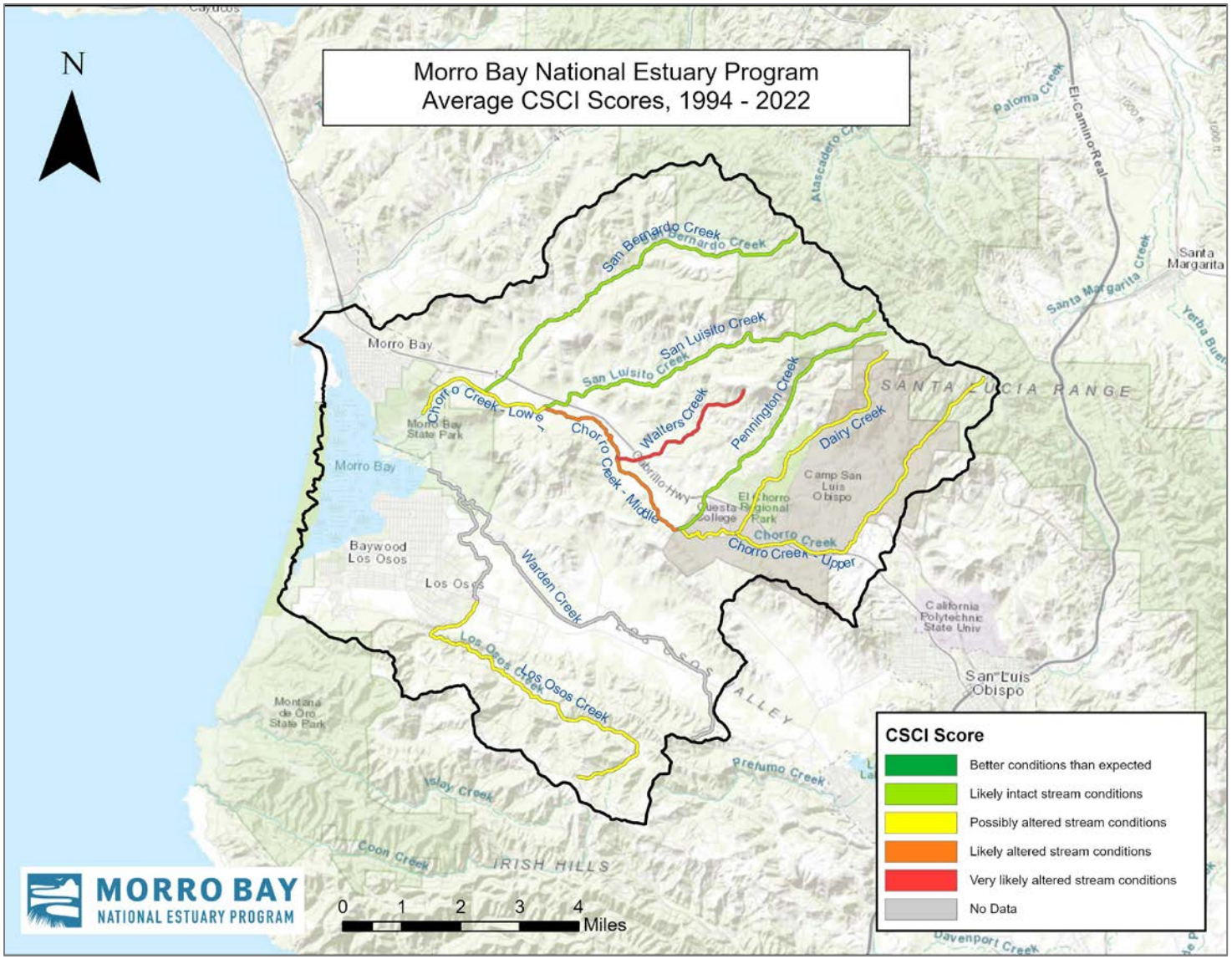

Figure 7. *Mainstem stream segments and their ecological health designations based on average CSCI scores from 1994 to 2022. Refer to Table 5 for more detailed information regarding individual site scores and number of data points.*

Conclusions

Staff and volunteers monitored ten sites during the 2022 bioassessment survey effort: five core sites (lower Chorro Creek at South Bay Blvd. [TWB], lower San Luisito Creek [LSL], upper Dairy Creek [DAU], Pennington Creek [UPN], and San Bernardo Creek [MNO]), two rotating sites (upper San Luisito Creek [USL] and Chorro Creek below the Chorro Reservoir [CHD]), and three potential reference sites (Pennington Creek [UNP, UMP] and upper Chorro Creek above the Chorro Reservoir [UCD]).

The metrics compiled for 2022 indicate stable conditions at the ten sites monitored. All CSCI scores were in the upper 50th percentile, showing moderate to exceptional conditions at each of the sites. Four of the ten sites had CSCI scores greater than 1.0, indicating "better ecological conditions than expected." These sites are Pennington Creek (UPN; CSCI = 1.14), upper Chorro Creek (UCD; CSCI = 1.04), lower San Luisito Creek (LSL; CSCI = 1.02), and upper San Luisito Creek (USL; CSCI = 1.02).

Past data has consistently shown moderate to poor stream conditions in middle Chorro Creek. Portions of upper Los Osos Creek have scores that have varied greatly, from "better than expected" (dark green) to "very likely altered" (red). Due to access limitations, the Estuary Program was unable to collect data along these two stream segments in 2022. Efforts are underway to regain access to these monitoring reaches for a more comprehensive assessment of conditions across the watershed.

For several years, the Estuary Program has sought a site to represent reference conditions in the Morro Bay watershed. Reference sites serve as a watershed-specific benchmark of ideal conditions against which other sites can be compared. In 2021, two potential reference sites, UNP and UMP, were established on upper Pennington Creek due to its excellent water quality and high-quality habitat. Despite seemingly favorable conditions in 2021, both sites yielded lower scores than expected. In 2022, these two sites were monitored again, and a new potential reference site was added on Upper Chorro Creek above the Chorro Reservoir (UCD). UNP and UMP scored even lower in 2022 than in 2021, each with scores in the "possibly altered" (yellow) score category. While there is insufficient data for analysis, conditions at UCD appear to better reflect reference conditions than the upper Pennington sites.

Prolonged periods of drought and low or intermittent flow conditions can have adverse implications for benthic invertebrate communities, leading to changes in community structure (Herbst et al., 2019). Water year (WY) 2022[3] was the third consecutive dry year in a series of extreme drought years, ranking as the ninth driest year on record for the state of California. While conditions during WY 2022 were slightly more temperate than in WY 2021, the January to March timeframe was amongst the driest three-month period on record (NOAA, 2023). During WY 2021 and WY 2022, San Luis Obispo County received less than half the amount of average rainfall. A rainfall gauge at the nearby California Polytechnic State University, San Luis Obispo (Cal Poly) indicates an average 21.8 inches of rain per year[4] (Cal Poly San Luis Obispo, 2017).

Partnerships

In 2021, the Harold J. Miossi Charitable Trust approached the Estuary Program about a partnership to expand bioassessment monitoring into the neighboring San Luis Obispo watershed. While the Estuary

[3] Water year 2022 (WY 2022) is defined as October 1, 2021 to September 30, 2022.
[4] This gauge is located approximately nine miles from the center of the Morro Bay watershed.

Program typically limits work to within the Morro Bay watershed, a goal of the program is to share expertise and resources that build capacity.

For a three-year period, the Estuary Program will work with Cal Poly and the City of San Luis Obispo to develop a bioassessment monitoring framework for the San Luis Obispo watershed. The first year of monitoring was completed in 2022 along five stream segments in the San Luis Obispo watershed. Results were compiled into a final report that is available for download through the Cal Poly Digital Commons website at: https://digitalcommons.calpoly.edu/nres_rpt/35/.

Future Efforts

While more conventional methods of water quality monitoring may capture instantaneous conditions, they cannot capture the overall aquatic health of a water body. Biotic data collected during bioassessment allows for a more complete picture of creek health. This data is of value to the Estuary Program, its partners, and to the CCRWQCB who utilizes this data to assess impairment in Central Coast waterbodies. Due to the value of this data to the program and its partners, the Estuary Program plans to continue annual bioassessment monitoring for the foreseeable future.

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This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement CE-98T25101 to the Bay Foundation of Morro Bay. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.